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Paving the way to a a meshed offshore grid Recommendations for an efficient policy and regulatory framework

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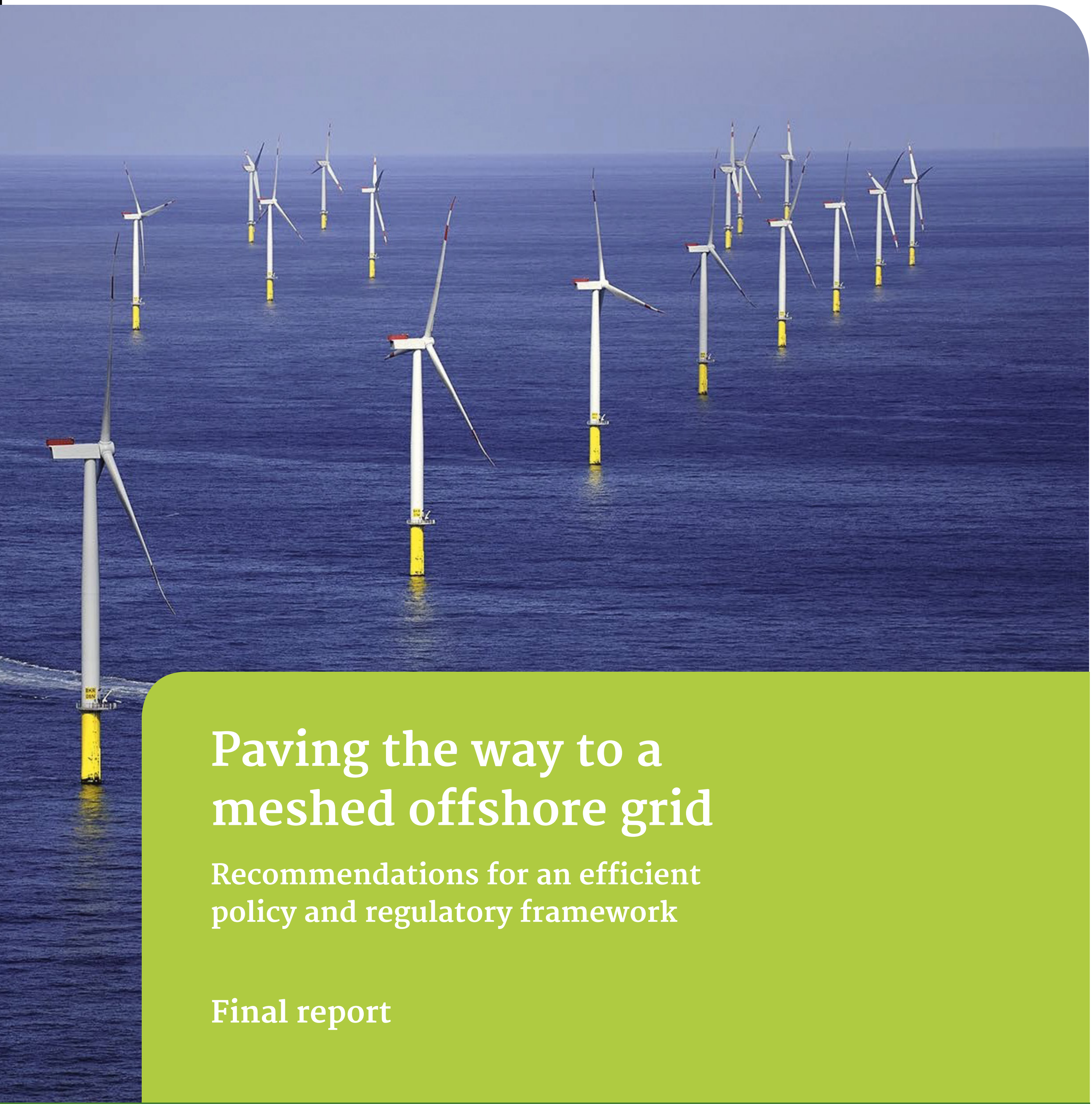

Paving the way to a meshed offshore grid

Recommendations for an efficient policy and regulatory framework

Final report

Interreg Baltic Sea Region

EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

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EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

Interreg Baltic Sea Region

EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

Baltic InteGrid

Paving the way to a a meshed offshore grid

Recommendations for an efficient policy and regulatory framework

by

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Glossary

Concept	Definition
Dual-purpose cable	Transmission cable which can alternatively or simultaneously act as interconnector or export cable.
Export cable	Transmission cable which connects an offshore wind farm to a (transmission grid) connection point. Traditionally, the connection is established between the power plant and the corresponding national onshore transmission grid, thus building a radial connection.
Hybrid project	Any offshore wind project which is not connected radially to the shore, or any offshore cable which does not solely act as an interconnector; that is, any project in which cables act simultaneously or alternately as interconnectors or export cables. The multiplication of hybrid projects in the Baltic Sea is expected to ultimately lead to the emergence of a meshed offshore grid.
Interconnector	Transmission cable which crosses or spans a border between Member States and which connects the national transmission systems of the Member States.
Meshed grid	In a meshed offshore grid, offshore wind farms are connected to more than one national transmission system. A characteristic of this grid architecture is the dual-purpose use of sea cables, which can serve alternately or simultaneously as interconnectors and export cables, and the possible routing of power from a given offshore wind farm to two or more national grids.

List of abbreviations

BSR	Baltic Sea Region
CBCA	Cross-border cost allocation
DK	Denmark
DE	Germany
EE	Estonia
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
EU	European Union
FI	Finland
LCOE	Levelised cost of energy
LV	Latvia
LT	Lithuania
MSP	Maritime spatial plan
MWh	Megawatt hour
PL	Poland
PCI	Project of Common Interest
SE	Sweden
SEA	Strategic environmental assessment
PCI	Project of Common Interest
SE	Sweden
SEA	Strategic environmental assessment

Baltic
InteGrid

Integrated Baltic Offshore
Wind Electricity Grid Development

Summary

Research conducted within the Interreg Baltic InteGrid project is intended to facilitate the establishment of a meshed offshore grid connecting offshore wind farms (OWFs) and national electricity markets in the Baltic Sea. To this end, the project partners have prepared three sets of recommendations for EU and national level stakeholders. This report elaborates on the partners' recommendations for the policy and regulatory fields, which are as follows:

Provide an adequate regulatory framework for investments in OWFs and grid projects:

1. Provide a harmonised method for the allocation of connection costs by:

- opting for a harmonised super-shallow cost allocation method for OWF connections in the Baltic Sea Region (BSR) to fully support the integration of offshore wind energy (OWE);
- connecting development areas for OWE with grid development plans; and
- organising a task force among all relevant stakeholders for future planning, for example within the Baltic Offshore Grid Forum, in order to limit cost overruns in network expansion and reinforcement.

2. Ensure an adequate institutional framework for OWE investments by:

- determining OWE expansion targets at national level;
- actively involving public authorities in the selection of suitable offshore wind production sites; and
- applying targeted institutional frameworks for the installation and operation of OWFs that provide reliable remuneration for project developers at selected locations.

3. Give transmission system operators (TSOs) coherent incentives to invest and operate meshed offshore grids by:

- adopting an incentive package for TSOs that promotes innovation; mitigates investment risks associated with meshed grid project development while limiting overall spending at TSO level; and couples TSO profit with the expected benefits of a meshed grid;
- achieving convergence across the regulatory regimes in the BSR to send harmonised signals to TSOs regarding investment incentives and performance; and
- forming a cooperation framework between relevant regulators and TSOs to implement a meshed offshore grid regulatory package that involves the transparent, reliable and unambiguous sharing of good practices.

4. Provide an investment framework for multilateral grid projects by:

- providing suitable regulatory conditions for multilateral grid investment projects, allocating cross-border network development expenses between the involved TSOs using an adapted methodology that accounts for the distribution of the expected benefits

and losses across countries; and
- reaching a high degree of cooperation between TSOs and the relevant authorities in defining and implementing jointly agreed cost allocation methods.

Provide an adequate legal framework for the construction and operation of a meshed offshore grid:

5. Ensure the legal feasibility of hybrid projects by:
- not making OWF permits conditional on feeding energy into the national transmission grid; and
- providing specific definitions and provisions for dual-purpose cables and meshed offshore grid infrastructures at the EU level.

6. Avoid distortions in connection location among offshore wind developers by:
- harmonising the signals sent by grid access tariffs in the BSR, where such tariffs reflect the usage cost incurred by the offshore wind operators, as set out in the EU Inter-TSO compensation mechanism regulation; and
- avoiding capacity-based fees.

7. Set rules for the operation of a meshed offshore grid by:
- establishing clear meshed grid operation rules at EU level;
- providing clear capacity allocation rules for OWFs connected through dual-purpose cables and ensure their access to the grid; and
- creating an overarching regulatory authority for a meshed offshore grid at EU or regional level and encouraging TSO cooperation.

Ensure environmental protection and increase public acceptance:

8. Balance project developers' interests and environmental protection by:
- Performing strategic environmental assessments (SEAs) as accurately and comprehensively as possible to shift the main assessment of environmental hazards at an earlier planning stage; and
- conducting a single environmental impact assessment (EIA) whose results can be reused at every successive procedural stage when several permits are needed for an OWF or grid project.

9. Increase public acceptance for offshore wind projects by:
- encouraging public participation as early as possible in grid and maritime planning processes; and
- providing flexible schemes and mechanisms to involve local communities in projects.

1. Introduction

1.1 Objectives

These recommendations, prepared by the Interreg Baltic InteGrid project partners, propose policy and regulatory adjustments at EU and national levels with the goal of eliminating existing obstacles to the development of a meshed offshore grid for OWE in the Baltic Sea. The recommendations are based on the findings from the Baltic InteGrid project,[1] in particular the reports "*Establishing an offshore meshed grid – Policy and regulatory aspects and barriers in the Baltic Sea Region*" (July 2018) and "*Economic considerations on the regulatory framework for offshore wind and offshore meshed grid investments*" (October 2018).[2] These recommendations are intended to assist public authorities, such as the EU Commission, national and regional governments, municipalities, and regulatory authorities (e.g. ACER); as well as stakeholders, such as ENTSO-E, national TSOs, and offshore wind operators.

1.2 Methodology

This deliverable is the continuation of previous publications within the Baltic InteGrid project. First, the project partners compiled inventories of policies and regulations relevant to transmission grids and offshore wind generation in all eight EU Member States located around the Baltic Sea. The partners then identified policy and regulatory barriers to the realisation of a meshed offshore grid in the Baltic Sea. Those barriers include:

- a lack of adequate incentives to invest in offshore wind technology;
- challenges associated with public acceptance of wind energy;
- insufficient (onshore) grid capacity to accommodate offshore electricity production;
- the use of obsolete cost information as a basis for offshore wind development, regardless of significant decreases in costs of OWE;[3]
- a lack of political will to develop the sector, as indicated by the failure to establish specific offshore wind targets in most EU BSR countries;
- constantly changing support schemes for electricity from renewable sources (RES-E); and
- complex administrative procedures required as part of the permitting process for grid and generation projects.

1.3 Meshed offshore grid rationale

In 2018, as much as 70% of Europe's offshore wind capacity was installed in the North Sea; only 12% of the continent's total installed capacity was located in the Baltic Sea.[4] Nevertheless, offshore wind development in the BSR has great potential due to the area's suitable wind conditions, shallow waters, short distances to shore, and low tides. Offshore wind energy development is expected to increase and accelerate in the BSR between now and 2050. Assuming moderate to high build out of offshore wind energy, a meshed offshore grid is the most efficient way to connect wind farms and countries in the BSR.[5] A meshed offshore grid would require a transition from the traditional grid architecture of radial OWF connections and separate, single interconnector cables to a regionally interconnected offshore grid. This grid architecture is characterised by the dual-purpose use of sea cables, which allows cables to serve alternatively and/or simultaneously as interconnectors and export cables, and by the possible route of electricity from a given OWF to two or more national grids and market zones (figure 1).

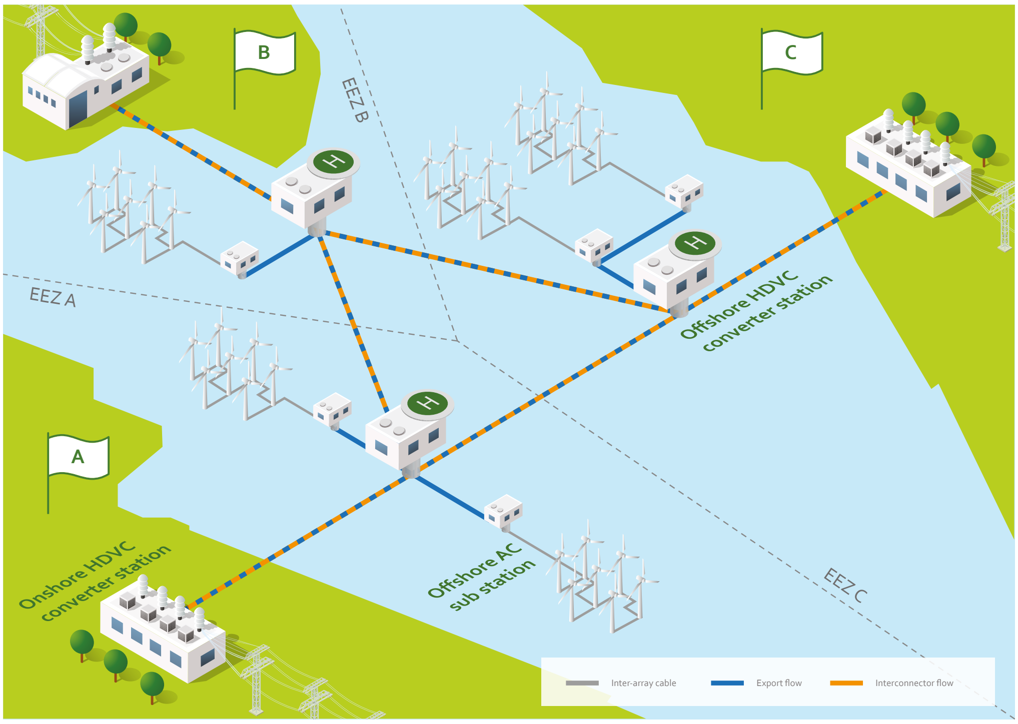

Figure 1. Architecture of a meshed offshore grid. | *Source: IKEM (2019)*

A meshed offshore grid can be achieved by implementing hybrid projects. These may be defined as any offshore wind project that is not connected radially to the shore, or as any offshore cable that does not act exclusively as an interconnector. An example of such a project is one that involves two OWFs, each located within a different country's Exclusive Economic Zone (EEZ), each connected to that country with an export cable, and both linked to each other by an interconnector. This solution is found in the Kriegers Flak Combined Grid Solution, a link currently under construction that will connect the Danish and German OWFs Kriegers Flak and Baltic 2 in 2019 (figure 2).[6] For the development of a meshed grid, it is necessary to ensure that these hybrid projects are not only legally feasible, but also properly incentivised.

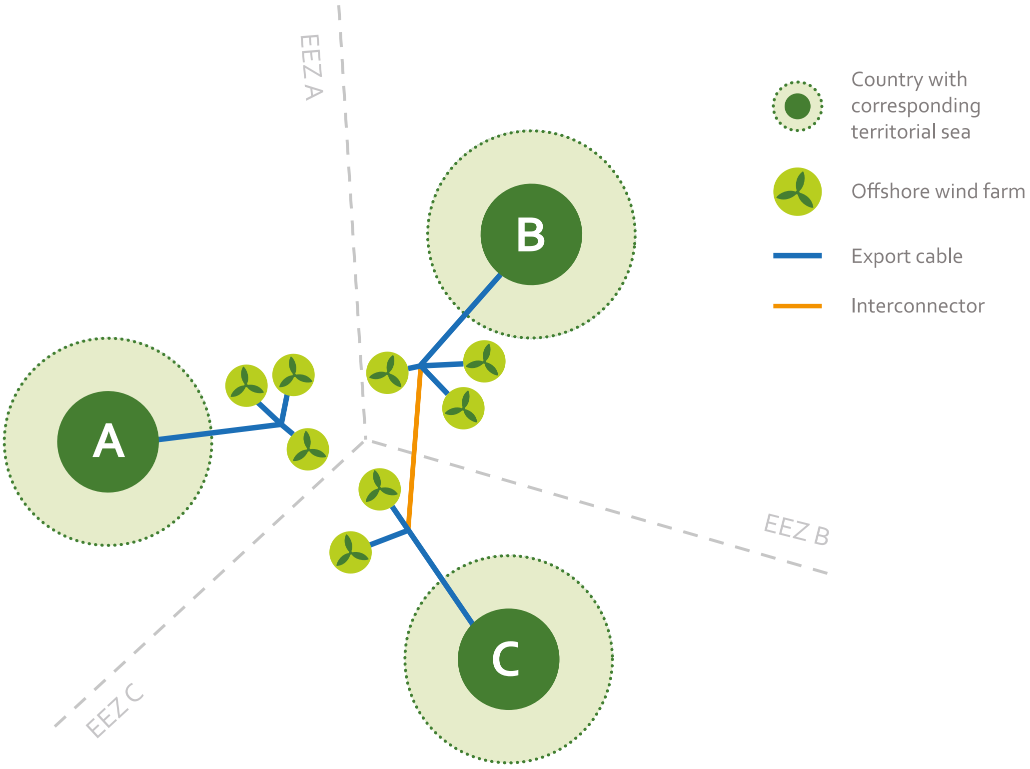

Figure 2. Example of a hybrid project: interconnection through OWFs (Kriegers Flak Combined Grid Solution). | Source: IKEM (2019)

An optimal use of available infrastructure is an important benefit of the meshed grid approach and allows for cost savings in grid infrastructure, as less subsea cables are needed to transmit the same amount of electricity.

The benefits of a meshed offshore grid are numerous. The dual use of connection cables, accommodating flows from OWFs as well as interconnection flows, permits a higher utilisation rate of the grid infrastructure. Some interconnectors in the EU are not being used at full capacity.[7] As of 2016, the BalticCable, for example, was not using 39% of its technical capacity; Estlink 1 used only 76%.[8] An **optimal use of available infrastructure** is an important benefit of the meshed grid approach and allows for cost savings in grid infrastructure, as less subsea cables are needed to transmit the same amount of electricity. Fewer subsea cables also mean that less maritime space is required, reducing the potential for conflict with other sea uses (e.g. fisheries) and minimising environmental impact. Another advantage lies in the numerous transmission routes for OWE to reach the onshore grid, which facilitates a higher system integration of electricity from renewable energy sources and offers greater resilience to OWF operators. Project partners also identified further benefits; for example, cost-sharing opportunities between investors in OWFs and TSOs reduce overall system costs while increasing system flexibility and cross-border energy trade. One final advantage specific to the BSR is the greater integration of the Baltic States into the EU energy system, which helps to end their energy isolation.

Despite these benefits, the development of a meshed offshore grid in the Baltic Sea faces **several challenges**, such as a high initial investment (even when offset by long-term efficiency savings) and the use of sophisticated new technologies. There are also significant challenges related to the policy and regulatory sphere, such as complicated regulatory frameworks that are not adapted to meshed infrastructure. These recommendations will outline key challenges and propose improvements and solutions.

2. Barriers and solutions for a meshed offshore grid in the Baltic Sea

Essential to the realisation of a meshed offshore grid in the Baltic Sea is the creation of a **coherent policy and regulatory framework** to address identified barriers. Recommendations addressed to stakeholders at EU and national levels were developed to address these issues and can be divided into three main categories: recommendations to achieve an adequate regulatory framework for investments in OWFs and grid projects (2.1), recommendations to achieve an adequate legal framework for the construction and operation of a meshed offshore grid (2.2), and recommendations to ensure environmental protection and increase public acceptance (2.3).

2.1 Provide an adequate regulatory framework for investments in OWFs and grid projects

It is necessary to provide an adequate regulatory framework for investments in OWFs. A clear, harmonised allocation of connection costs for OWFs in the Baltic Sea is required so that project developers can choose the best location for their projects regardless of connection costs. Adequate remuneration schemes are necessary. Investments in meshed offshore grid infrastructures must also be incentivised. For example, incentive packages for TSOs should be offered to promote innovation and mitigate investment risks associated with meshed grid project development. In addition, adapted methodologies should be developed to allocate cross-border network development expenses in meshed offshore grids between the involved TSOs.

Incentive packages for TSOs should be offered to promote innovation and mitigate investment risks associated with meshed grid project development.

2.1.1 Provide a harmonised method for allocating connection costs

Issue:

The diversity of grid connection cost allocation methods (figure 3) that apply in the Baltic Sea Region may severely undermine the completion of meshed offshore grid projects. Grid connection approaches reflect how the costs associated with network expansion and reinforcement to connect an offshore wind farm should be split between the offshore wind operator and the TSO and are set at the national level. Discrepancies result in different financial and regulatory risks borne by the involved stakeholders and in distortions perceived by the market actors on where to locate their park, possibly at the expense of the best location in terms of wind conditions. The different conditions for connection create an uneven playing field among offshore wind farm operators in sending different signals that will ultimately reflect on their bidding strategy and profitability.

One way to create a level playing field is to **harmonise the distribution of connection costs** between TSOs and OWF operators in the Baltic Sea. Ideally, the construction of offshore grid infrastructure and the connection of OWFs should pose little to no risk to offshore wind operators. Simplicity in cost distribution methodology, particularly in the case of multiple stakeholders, should be prioritised to limit potential delays or disputes during the development phase. It is recommended to use a **super-shallow cost-allocation** approach (figure 3), whereby the offshore wind operator bears the connection costs only up to the point of connection with the offshore grid.

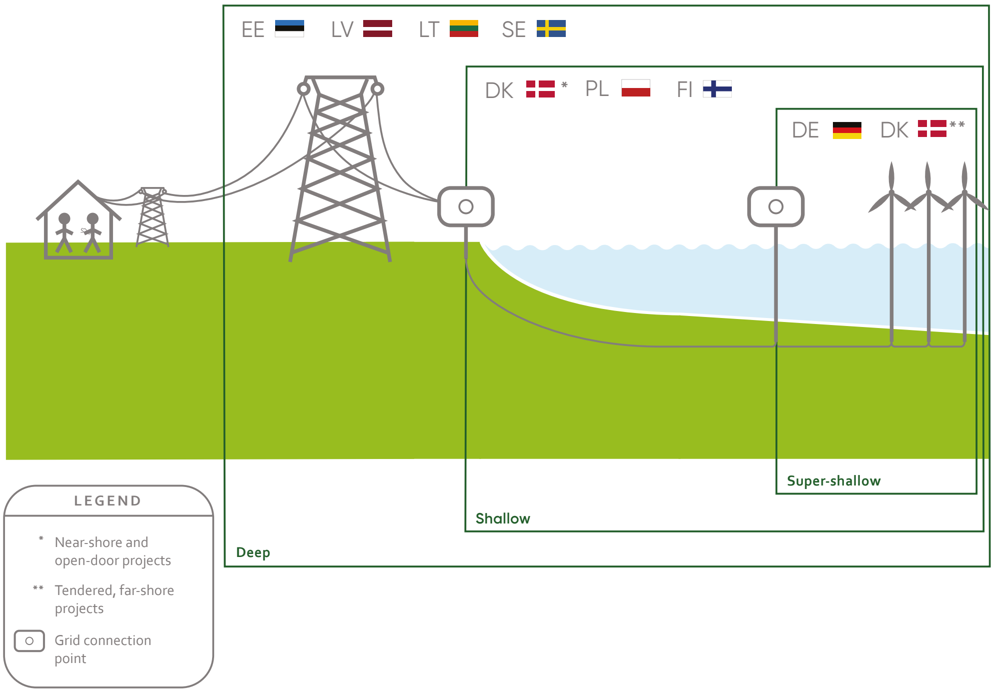

Figure 3. Cost-allocation approaches. | *Source: IKEM (2018)*[9]

In the super-shallow approach, the TSO is responsible for the overall expansion of the grid infrastructure and for the potential reinforcement of the existing onshore grid, which is made necessary by the increase of power flows associated with the new offshore wind generation. A super-shallow approach is currently used in Denmark for tendered OWF projects, for instance in the Kriegers Flak project (although this approach is currently under discussion). It is also part of the new German legal framework for the tendering of offshore wind capacity in the EEZ.

A balance should be found between appropriate siting of the OWFs and least-cost grid development in order to avoid uncontrolled network expenses.

On the downside, a super-shallow approach can mask locational signals: since the offshore wind developer does not need to consider the connection costs in choosing a location, cost overruns in building new lines may occur. Accordingly, a balance should be found between appropriate siting of the OWFs and least-cost grid development in order to avoid uncontrolled network expenses. One way to address this is to create a **regional task force** involving the energy regulatory authorities, maritime spatial planners, TSOs, and representatives of the wind energy sector in the relevant countries of the BSR. This task force could draw up a series of scenarios and roadmaps to possible meshed offshore grid planning, taking care to reflect the different stakeholders' constraints and aiming to maximise the overall efficiency at the meshed grid level. The task force could be institutionalised either at EU level or via multilateral agreements between the involved countries.

Recommendation:

- Opt for a harmonised, super-shallow cost allocation method for OWF connections in the BSR to fully support the integration of OWE;
- Connect development areas for OWE with grid development plans and organise a task force among all relevant stakeholders for future planning, e.g. within the Baltic Offshore Grid Forum, to limit cost overruns in network expansion and reinforcement.

2.1.2 Ensure an adequate institutional framework for OWE investments

Issue:

The costs of OWE generation projects highly depend on the institutional framework for the construction and operation of wind farms, which determines the possibilities for investors to generate revenues. The ‘energy-only market’ approach, in which investment decisions are decentralised, cannot be regarded as a suitable concept for investments, as investors face high market risks that translate into substantial increases in the cost of capital. Furthermore, such decentralised investment decisions, including in the selection of production sites, impede an efficient coordination of generation and grid planning.

Due to the specific requirements of OWE and the complexity of building a meshed offshore grid, public authorities should be involved in the process of selecting and developing **suitable production sites**. Public authorities are involved, for example, when areas for potential offshore wind development are identified in maritime spatial plans (MSPs) or selected for tendering, while investors subsequently compete for the construction and operation of OWFs at the chosen locations. Such frameworks tend to limit the amount of stranded investments and allow for harnessing synergies from integrated generation and grid planning. The contracts for investors who implement OWE projects should include a targeted allocation of risks (such as quantity and cost risks) to create incentives for efficient investment-related and operational decisions. To avoid cost increases, the revenue of generators who are awarded contracts should not be highly dependent on uncertain market developments.

The Renewable Energy Directive 2009/28/EC sets minimal binding targets for the share of energy from renewable sources within the Member States’ gross final consumption of energy in 2020.

Sliding market premiums, for example, are recommended remuneration schemes because, in principle, they offer a high potential for limiting costs. These should be technology-specific due to the substantial differences between available technologies, which make it more reasonable to carry out a targeted procurement based on individually adapted institutional frameworks. Because some degree of consistency and predictability in regulatory action is an elementary component of investment-friendly institutional frameworks, care should be taken to avoid the problems associated with sudden paradigm shifts.

Tendering allows for the selection of generators, the determination of remuneration levels, and it gives public authorities control over the generation capacity installed in their sovereign waters.

In countries with significant OWE capacity, **tenders** are suitable instruments for selecting generators and determining remuneration levels. This approach is currently used in the Danish offshore wind tendering scheme and in the "central model" that will soon be applied in Germany in accordance with a recent reform. Furthermore, tendering allows public authorities to control the generation capacity installed in their sovereign waters. It is a suitable instrument for the implementation of specific **OWE targets**, which should be adopted by the central governments or regions of Member States to encourage the expansion of OWE capacity in the Baltic Sea.

In the case of innovative projects and countries entering the offshore wind market for the first time, incentives such as remuneration schemes should minimise the perceived risk to investors and compensate for the additional risk associated with the novelty of the project. This would allow the technology to compete with other energy sources that receive subsidies, primarily fossil fuels and nuclear. Once an emerging market reaches maturity, a transition towards a competition-based payment system is recommended, provided that enough visibility is given to investors so that they are aware of upcoming changes when they make their investment decisions.

With the costs for offshore wind development rapidly decreasing, it is likely that, in the medium term, offshore wind can be developed competitively without subsidies. However, the decision to abandon remuneration for OWE in the future must be considered carefully, as cost and income will vary from project to project.

Recommendations:

- Determine OWE expansion targets at national level;
- Actively involve public authorities in the selection of suitable of offshore wind production sites; and
- Apply targeted institutional frameworks for the installation and operation of OWFs that provide reliable remuneration payments for project developers at selected locations, possibly via tendering.

2.1.3 Give TSOs coherent incentives to invest in and operate meshed offshore grids

Issue:

The expenses associated with the TSOs' activities to develop and operate their systems are ultimately paid by the final consumers through grid tariffs. The extent to which TSOs can recover these costs, and the methods allowed for doing so, is strictly regulated at national level; regulatory agencies decide on a series of incentive instruments and objectives for TSOs' cost recovery and determine how they can perform their duties. The countries around the Baltic Sea have very diverse regulatory regimes for TSO cost recovery. This diversity presents the TSOs with multiple incentives for investment and operation. Ultimately, the lack of harmonisation in the incentive instruments creates uneven financial risks among the TSOs that would jointly invest in meshed offshore grid projects.

The regulatory regime is implemented by regulators and aims to ensure that the TSOs perform their duties in an efficient way. For that, regulators use a series of incentive instruments and mechanisms associated with the different capital and operation expenditures. For example, investments could be incentivised by eliminating the financial risk associated to a given spending through authorising a complete pass-through of the expense in the tariff. An instrument could also grant a premium to complete certain project deemed strategic or risky or else reward improved quality performance. Regulatory bodies can play a critical role in promoting meshed grid projects by creating a set of incentive instruments and mechanisms that drive investment choices towards a meshed offshore grid solution rather than traditional radial connections and interconnections.

Regulators should create incentive instruments that drive investment choices towards a meshed offshore grid solution rather than traditional radial connections and interconnections.

A **supportive regulatory regime** should build on the features of meshed offshore grids as an investment. A meshed grid is deemed innovative, capital-intensive, with the potential for unlocking large efficiency gains and socio-economic benefits, and requiring strong cross-border coordination. Adapted incentive instruments should support R&D activities and guarantee that the total cost of building the meshed offshore grid is passed through in the tariffs and remunerated with a rate of return that captures the risk of investing in such a project. A regulatory regime for cost recovery should at least facilitate innovation, limit the financial risks of meshed offshore grid development, couple the TSO's profit to expected benefits, and limit overall TSO spending.

The implementation of such a framework presupposes a distinction between expenses incurred to complete meshed offshore grid projects and the remaining expenses incurred by the TSOs in their respective territories. The inherent investment risk associated with hybrid projects should receive a different treatment than the controllable expenses for which cost uncertainty is low. The novelty of meshed offshore grids and their transnational nature increases the risk of cost overruns, including from inaccurate cost estimates or delayed implementation due to coordination difficulties. It is critical that all involved TSOs receive coherent regulatory signals when developing these projects. A portfolio of performance-based indicators is generally used to evaluate the quality of the TSOs. To stimulate investment, profit-making could be coupled to the expected benefits of a meshed offshore grid through the development of dedicated performance indicators. The scope of performance-based instruments (e.g. financial rewards and fines) in meshed offshore grids is limited, however, due to multiple factors. These include the non-monetised nature of some benefits and the inability to assess their impact at a national level alone, which prevents them from being captured in a national-based performance indicator. Performance indicators are based on the non-harmonised set of available performance data across countries, which adds another level of complexity. **Cross-border coordination** – e.g. in pooling key regulatory competences, sharing expertise, and deciding jointly on best-suited incentive instruments – would bring coherence to the regulatory regimes in the BSR and mitigate differences in regulators' resources.

Cross-border coordination would bring coherence to the regulatory regimes in the BSR and mitigate differences in regulators' resources.

Recommendations:

- Adopt an incentive package for TSOs to promote innovation; mitigate investment risks associated with meshed grid project development while limiting overall spending at the TSO level; and couple TSO profits to the expected benefits of a meshed grid;
- Achieve convergence across the regulatory regimes in the BSR so that signals sent to the involved TSOs are harmonised in terms of investment incentives and performance;
- Implement a cooperation framework among the involved regulators and TSOs to implement a meshed offshore grid regulatory package that includes the transparent, reliable, and unambiguous sharing of good practices.

2.1.4 Provide an investment framework for multilateral grid projects

Issue:

Another issue lies in the cost distribution dilemma between TSOs involved in a multilateral grid project. It is necessary to implement an investment framework for such projects that apportions each stakeholder's participation according to the benefits expected from the project. The interlinkage between electricity infrastructure development and the pursuit of national interest by policymakers is strong and may affect cross-border infrastructure plans and investment cooperation at the expense of benefits and welfare in the BSR.

The lack of strong cooperation between national authorities and between TSOs is a critical risk factor in the completion of meshed offshore grids. Transnational electricity infrastructures are currently limited to interconnectors that connect two national transmission systems — and TSOs — under bilateral agreements, which generally stipulate cost-sharing on a 50/50 basis. Meshed offshore grids expand the scope of such agreements to include more stakeholders - including additional TSOs - , who are likely to benefit from the new infrastructure as well.

In an investment framework where the withdrawal or the non-cooperation of an actor can jeopardise the project, new cross-border cost-allocation methodologies must be jointly discussed and agreed upon. These methodologies should be able to capture the array of benefits generated by meshed offshore grids, in terms of both their monetised value (effects on market prices due to increased interconnection and better integration of low-cost energy, reduced congestions, etc.) and non-monetised value (increased security of supply, faster transition to a low-carbon energy system). Accordingly, a suitable cross-border cost-allocation framework should also consider welfare losses potentially incurred by countries as a result of the project. A fair allocation of costs and benefits would therefore limit the interference of national interests in regional welfare without overriding national sovereignty and give the green light to multilateral projects.

The Cross-Border Cost Allocation (CBCA) method used in EU Projects of Common Interest (PCIs) can be used as a guideline, because it captures multilateral investment constraints and accounts for some non-monetised benefits. However, due to the fact that each TSO performs its own CBCA calculations, a simple generalisation of the CBCA tool is not sufficient to fully address multilateral investment challenges. Rather, it requires a dedicated legal framework based on suitable cooperation structures which will be implemented at EU level, or at least at regional level in the BSR. The efficiency of this tool will depend on the capability of institutions to develop the required structures and frameworks, as well as on the level of cooperation between the TSOs, the national regulatory bodies, and all relevant stakeholders in defining cost-sharing methodologies and sharing knowledge. While the framework for such effort should be drafted at the supranational level, what is needed is the political will for stronger cooperation and the alignment of different national policy pathways towards a common EU/regional vision.

What is needed is the political will for stronger cooperation and the alignment of different national policy pathways towards a common EU/ regional vision.

Recommendations:

- Cross-border network development expenses in meshed offshore grids should be allocated between the involved TSOs using an adapted methodology in a fair, cost-efficient, and transparent way, taking into consideration the distribution of the expected benefits and losses across countries;
- Reach a high degree of cooperation between TSOs and the relevant public authorities in defining and implementing jointly agreed cost-allocation methods (e.g. through a task force created at EU or regional level).

2.2 Provide an adequate legal framework for the construction and operation of a meshed offshore grid

Another goal of these project recommendations is to incite policymakers to provide an adequate legal framework for the construction and operation of a meshed offshore grid. The legal feasibility of hybrid projects must not be hindered by permit requirements that presuppose a radial connection to the national onshore grid. The signal sent by grid access tariffs in the meshed grid should be harmonised. Finally, once the meshed offshore grid is built, its operation must be adequately regulated under a framework that contains specific definitions and provisions for the specific meshed grid infrastructure.

2.2.1 Ensure the legal feasibility of hybrid projects

Issue:

The realisation of a hybrid project (e.g. an OWF connected to an interconnector) can be challenging from a legal perspective. EU and national legal frameworks for grid connections are designed based on a radial architecture. There is currently no definition or mention of dual-purpose cables in the relevant provisions of EU law. National legal frameworks may also hinder hybrid projects. In Germany, for example, the 2017 Offshore Wind Energy Act states that an OWF can only obtain a construction permit in the EEZ if it has previously won a tendering procedure, which presupposes that it will feed its electricity into the national grid. This, in turn, presupposes a radial connection. Such requirements may deter developers from investing in hybrid projects.

Precise legal definitions are needed as well as provisions setting rules for the ownership and operation of dual-purpose cables.

To make hybrid projects legally feasible, Member States should not make permits for OWFs conditional on the farms' feed-in into the national grid and thus their radial connection to the national transmission grid. Investors should be able to develop offshore wind projects independently of national grid-connection requirements. This may require consenting and planning procedures to deviate from the procedures for the classical configuration. The EU should also introduce **specific provisions for dual-purpose cables**. Precise legal definitions are needed as well as provisions setting rules for the ownership and operation of dual-purpose cables. These definitions will help reduce some of the uncertainty around hybrid projects and signal to Member States that hybrid projects can be encouraged by ensuring their legal feasibility.

Recommendations:

- The permit for an OWF should not be conditional on its being connected radially to the national transmission grid;
- Specific definitions and provisions for dual-purpose cables and meshed offshore grids should be set at the EU level.

2.2.2 Harmonise the signals sent by grid access tariffs in the meshed grid

Issue:

Grid tariffs for OWF access to the transmission grid are set at national level. Because tariff designs vary among BSR countries different signals are sent to the OWF operators willing to connect to the same infrastructure. Currently, only OWE generators connected to (most of the) Danish, Finnish, and Swedish grids must pay a grid access tariff, and each of these countries applies a different tariff design. In the other countries around the Baltic Sea, offshore wind is exempted to pay an access fee. The question of convergence in grid access tariffs in the EU is considered a secondary issue at this time but is expected to become increasingly important with the completion of the internal energy market and the energy transition.[10] In the context of offshore wind, different tariff designs impact the business case for generators and may affect their choice of location based on which TSO offers the most advantageous conditions for grid use. This is likely to result in the selection of locations with suboptimal wind conditions. The multitude of existing grid tariffs in a meshed offshore grid therefore creates distortions among developers and uneven business opportunities on the same infrastructure.

In connecting to the grid, each user, consumer, or producer generates a cost to the grid operator in the form of investments to build and maintain the network or costs of energy transmission on the lines, e.g. due to energy losses or ancillary services. Grid tariffs cover these costs. Because most of these network expenses are due to building the infrastructure and are sunk fixed costs (i.e. they cannot be directly allocated to a specific grid user), the costs are shared among users based on criteria that generally reflect energy policy objectives, such as the promotion of equity among consumers or use of renewable energy.

An appropriate distribution between fixed and variable cost components in the tariff encourages efficient dispatch and congestion management and sends signals to the TSO that guide future investments. In an international constellation such as a meshed offshore grid, the imposition of different tariffs on the same category of actor sends different signals to that actor. A 100% energy-based tariff charges a fixed fee for each unit of energy that is fed into the grid and results in the internalisation of the tariff in the producer's bidding strategy on the wholesale market since the tariff ultimately adds on the energy cost per unit. On the other hand, a 100% capacity-based tariff applies a fixed fee based on the installed capacity. This tariff design is less favourable for production units with low running hours such as wind turbines as it has a greater impact on the levelised cost of energy (LCOE) of the intermittent unit, potentially jeopardising investments.

An initiative to improve tariff convergence in the EU was introduced in the Inter-TSO Compensation Regulation.[11] The Regulation sets a cap on the energy component at a level that approximates the real value of the variable costs; however, its scope is limited due to exemptions granted to some countries, including Denmark, Sweden, and Finland. Recommendations on tariff design are challenging, however, because such design is tightly linked to the legal definition of the infrastructure (i.e. interconnection, transmission grid, or dual-purpose), which dictates the applicable rules for grid access. If the connection point is considered part of the transmission grid, the grid tariff should be set among the involved TSOs in a way that sends appropriate economic signals and creates a level playing field, at least in the BSR or at the internal market level.[12] Like the distribution of connection costs, locational signals should be minimised to support locational choices based on wind conditions.

Like the distribution of connection costs, locational signals should be minimised to support locational choices based on wind conditions.

Recommendations:

- Harmonise the signal sent by the grid access tariff in the BSR through a coherent tariff design rather than a single access tariff that would be disconnected from the TSO's physical asset costs;
- Design the tariff to reflect the utilisation cost (variable costs) incurred by the generators (including the offshore wind operators) and avoid capacity-based fees.

2.2.3 Set rules for the operation of a meshed offshore grid

Issue:

The current grid-operation rules are not suitable for the constellation of a meshed offshore grid due to the dual-purpose use of its transmission cables and its multilateral implications. The EU's strict unbundling rules can lead to uncertainties regarding who may operate dual-purpose cables, which are not legally defined. Furthermore, non-discrimination rules and third-party access to interconnectors conflict with the guaranteed access of OWFs to the transmission grid. Finally, the operation of parts of the meshed grid by the respective national TSOs can lead the operation of the entire meshed grid to lack overall coordination.

The configuration in which a cable is used at the same time as an interconnector and an export cable is not considered in EU legal provisions. This can be an issue, as the simultaneous or even alternative use of a cable could lead to conflicts regarding which actor may operate the cable and in what way. Existing rules on construction, maintenance, and financing, for example, are designed in view of a single use only. This single use also defines which stakeholder may operate the cable under a strict application of unbundling rules. The EU should introduce specific provisions for dual-purpose cables to clarify the allocation of such tasks.

A lower system integration of OWE may arise from the connection to a dual-purpose cable. The cable's limited transmission capacity must accommodate both the cross-border flows and the electricity produced by OWFs. This may result in curtailment in cases where the cable cannot fully accommodate both flows. In this respect, the operator's claim to grid access conflicts with the rules of non-discriminatory access to interconnector capacity. To optimise the system integration of OWE, it is necessary to allocate clear priorities between the OWE and interconnection flows. Depending on the chosen solution, EU legal provisions on the non-discriminatory allocation of interconnector flows may need to be amended. Implicit auctions, which rely on the day-ahead transmission capacity, would be one way to allocate interconnector capacity while accounting for the needs of an OWF.

Finally, an efficient operation of a meshed offshore grid involving more than two countries calls for a **coordination of the respective TSOs' tasks at an interregional level**. The overarching surveillance and operation of a meshed offshore grid could be the task of an authority at the EU or regional level, such as a Regional Operation Centre, Regional Security Centre, regulatory agency, or even a single regional TSO operating the whole meshed offshore grid. The creation of an operational body acting at a regional scale could be the springboard for the development of operation rules that are coherent and surpass national interests. Moreover, the role played by the individual TSOs is crucial, and coordination between grid operators must be encouraged.

The creation of an operational body acting at a regional scale could be the springboard for the development of operation rules that are coherent and surpass national interests.

Recommendations:

- Provide clear meshed grid operation rules at EU level;
- Provide clear capacity-allocation rules for OWFs connected through dual-purpose cables and ensure their access to the grid;
- Create an overarching regulatory authority for a meshed offshore grid at EU or regional level in the BSR and encourage TSO cooperation.

2.3 Ensure environmental protection and increase public acceptance

It is crucial to guarantee environmental protection and increase public acceptance of offshore wind and grid development in order to ensure community receptivity, as strong opposition from the public can ultimately lead to project failure. Project developers' interests and environmental protection should be adequately balanced, for example by performing the main assessment of possible environmental hazards associated with a meshed offshore grid at an earlier planning stage and ensuring that reliable environmental procedures are included in project planning. Flexible schemes and mechanisms to involve local communities in offshore wind projects can also encourage public acceptance.

Project developers' interests and environmental protection should be adequately balanced.

2.3.1 Balance project developers' interests and environmental protection

Issue:

The environmental impact of a spatial plan to dedicate a given area to offshore wind production or of a concrete construction project must be evaluated in an SEA. These assessments may incorporate two basic principles of environmental law that may lead a plan or project to fail: the precautionary principle and the prevention principle. The precautionary principle is based on the theoretical possibility that environmental damage could result from the project ("abstract hazard"), whereas the prevention principle applies only when there is sufficient probability that damage will occur ("concrete hazard"). This distinction is embedded in the environmental law of several countries in the BSR, such as Estonia and Germany. Because there is considerable uncertainty regarding the environmental impact of OWE production, and because the technology is relatively new, strict application of the precautionary principle can lead to the failure of many projects and may compromise the energy transition. Furthermore, in countries where numerous authorisation permits are required, several EIAs may be conducted and produce different results; this, in turn, may increase the level of uncertainty for investors.

One way to ensure an optimal balance between environmental conservation and ambitious OWE development is to make fair use of environmental law. To provide for a transparent and non-discriminatory assessment of the potential environmental impacts of offshore wind generation in a maritime environment, it is necessary to assess this issue comprehensively as early as the abstract planning phase. When SEAs are conducted during the drawing-up of MSPs where certain areas are reserved for offshore wind production, they should **assess these potential impacts as accurately and comprehensively as possible**. These results can then be reused at a later stage during project EIAs. One advantage of this method is that it can provide project developers with greater certainty regarding the environmental feasibility of their projects.

Offshore wind developers must also be aware of environmental constraints, and environmental law should be used by public authorities in a transparent and adequate manner while performing EIAs. Because public authorities have more discretion in applying the precautionary principle, risk analysis methods should be as transparent as possible for the offshore wind developers. The threshold above which a hazard is considered "sufficiently probable" to stop a project should be set with transparent criteria allowing for an ambitious level of nature protection and which can be easily assessed by a higher administrative authority or administrative court.

A single authority assessing all the needed permits and criteria as part of one single administrative procedure is recommended for efficient meshed offshore grid development.

Regarding the design of permitting procedures for OWE and grid projects, it is necessary to reduce the number of permits needed, with a single authority assessing all the needed permits and criteria as part of one single administrative procedure that delivers a single permit (**"concentration effect"**) – as is the case for OWF projects in Germany. The generalisation of **one-stop shops**, as required under Art. 16 of the recast Renewable Energy Directive,[13] meaning that a project developer only has contact with one contact point throughout the procedure, is already a step in the right direction. In addition to lowering the administrative burden on project developers, a single permit with a concentration effect would be advantageous because it would require only one EIA per project. In countries where several permits would still be needed for one project (e.g. a permit to use the sea bed or a construction permit) an alternative solution would be to carry out one single comprehensive EIA, which results can be reused at further stages of the procedure, once all the parameters of the project are known (e.g. turbine model, pattern, or number of turbines).

Recommendations:

- SEAs should be as accurate and comprehensive as possible to shift the main assessment of environmental hazards to an earlier stage;
- EIAs should be performed in a transparent and fair manner to provide offshore wind investors with the greatest possible security;
- One comprehensive EIA per offshore wind project should be carried out once all the parameters of the project are known.

2.3.2 Increase public acceptance for offshore wind projects

Issue:

The lack of public acceptance is a potential barrier to the realisation of offshore wind and grid projects, as EU law, and thus the law of the Member States, requires entities, especially environmental associations, to have legal recourse to challenge project permits. Legal action by third parties can lead to delays in planning (as has been the case with the Estonian Tuulepark) and even to the eventual failure of OWFs or grid construction projects. A lack of public acceptance is more likely to concern near-shore projects. Although public acceptance can be increased by involving the public early in the planning phases of a project, public participation in environmental assessments does not always ensure a satisfactory balance of interests or guarantee public support in the affected communities or sectors.

Early involvement of the public is vital to encourage public support and positive attitudes.

To encourage public support and positive attitudes, early involvement of the public is vital. Public participation should be encouraged as early as the pre-planning stage for the locations of potential future offshore and near-coastal wind farms (e.g. during the SEA for an MSP).

Furthermore, the regulatory framework should provide incentives for the public that are sufficient to increase acceptance. When planning for offshore wind projects in near-coastal areas or at distances where wind turbines are visible from land, the project developer and competent authorities can accommodate public opposition by providing schemes or mechanisms which provide certain benefits to the community. This framework should be flexible enough to account for the variety of stakeholders involved in or affected by a project, as their objections – and therefore possible incentives – may be very diverse. Stakeholders' needs may include involvement, information, or, ultimately, financial compensation.

Such mechanisms may consist of co-ownership schemes, such as those in which a larger group of citizens each acquire a minor share in a wind energy project, thus allowing citizens as a group to make large investments. A feature of the Danish Renewable Energy Act is the obligation to offer local citizens a minimum of 20% ownership of a wind energy project. Project developers must invite members of the local community to participate financially in the project and become co-owners. The mechanism, which applies to all new near-shore projects, is based on the assumption that financial involvement can have a positive effect on local attitudes. The buying option is exercised through a tender procedure conducted by the developer. The shares are only offered to citizens owning dwellings in a municipality that has a coastline within 16 km from the location of the nearest wind turbine. **Community benefits** may also encourage local acceptance. They provide an immediate advantage to the local community and compensate for the local impacts of the project. This can be illustrated by the response to citizen opposition in the Smalininkai project in Lithuania: part of the income from the electricity produced is reinvested in improving the town infrastructure. Such measures may provide a stable source of revenue for the local community during the lifetime of the wind project and may thereby increase acceptance.

Community benefits may also encourage local acceptance, by providing an immediate advantage to the local population.

A more controversial mechanism can be used for near-shore projects. Owners located in the vicinity of an OWF are offered potential compensation for loss of property value. The effectiveness of this compensation in increasing public acceptance is subject to discussion, as it can signal an acknowledgement that OWFs are “a nuisance” and thus augment negative public perceptions. Furthermore, studies concerning the loss in value of dwellings located in the vicinity of OWFs have led to contradictory results.[14]

Recommendations:

- Encourage public participation as early as possible, namely at the maritime spatial planning stage;
- Provide flexible schemes and mechanisms to involve local communities in offshore wind projects.

3. Conclusion

The EU has been at the forefront of climate policy and renewable energy development, pledging to reduce emissions by 80%–95% by 2050 while further interconnecting electricity markets. A meshed offshore grid could make an important contribution to tomorrow's sustainable, integrated energy landscape. For the BSR, this grid configuration has the potential to optimise infrastructure investments, utilise cable infrastructure more efficiently, connect national electricity markets, reduce the risk of curtailment, and boost system stability.

While a meshed offshore grid has many benefits, it is also characterised by a highly complex multilateral and capital-intensive nature. The current development of hybrid projects reflects the willingness of stakeholders to pave the way for a meshed and efficient energy system in the EU. The declining costs of OWE and advancements in grid technology are positive market signals for innovative solutions. From the North Sea Wind Power Hub to the Kriegers Flak Combined Grid Solution, investors and stakeholders are demonstrating that the market is ready for new, visionary concepts related to OWE distribution and transnational planning. It is crucial that this interest translates into a forward-looking policy framework and enhanced cooperation between Member States and stakeholders at the regional level.

These recommendations aim to assist in developing an adequate policy and regulatory framework that can deliver the full benefits of a meshed offshore grid and ambitious wind electricity production in the BSR. To tap into the long-term socio-economic benefits of a meshed offshore grid, upfront or short-term incentives must be provided to reduce the complexity and risks confronting investors. Such incentives must be designed as part of a holistic policy and regulatory framework that can unlock the full potential of both a meshed offshore grid and ambitious offshore wind electricity production. The development of such a framework requires a strong commitment from policymakers and regulators to look beyond national interests. EU institutions now have a critical role to play in laying the groundwork for a stable and harmonised institutional framework for the operation of an interregional meshed offshore grid in the Baltic Sea.

With 2.2 GW of installed capacity and rising, the offshore wind market in the Baltic Sea is on the cusp of accelerated development, and the grid infrastructure that will connect this additional capacity is not yet planned. The time is right for the EU to continue its leadership of the energy transition by spearheading bold policymaking initiatives and green innovation in offshore wind grid infrastructure.

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End notes

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